Pollution Prevention at Los Alamos National Laboratory

Mixed Low Level Waste Oil at TA-55

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The Challenge

Waste oil generated at TA-55 is currently being disposed of as Mixed Low Level Waste (MLLW). A total of between 0.5 m^3 and 1.0 m^3 of this waste is generated annually. Disposal is expensive and time consuming. The Environmental Stewardship Office challenged Nuclear Materials Technology (NMT) Division to eliminate this waste stream. NMT Division responded to this challenge by agreeing to apply the Green Zia systems approach to address this problem.

This paper will discuss how NMT Division used the following tools to address the issues involved with MLLW oil.

- Determining opportunities in the current process using process maps.
- Rank ordering of the opportunities to improve the process using Pareto Analysis and activity based costing.
- Determining the root cause of the selected opportunity using a cause and effect (fishbone) diagram.
- Generating process alternatives.
- Selecting alternatives using a forced pairs comparison.
- Implementing the selected alternatives with a formal action plan.

TA-55 MLLW Oil Team

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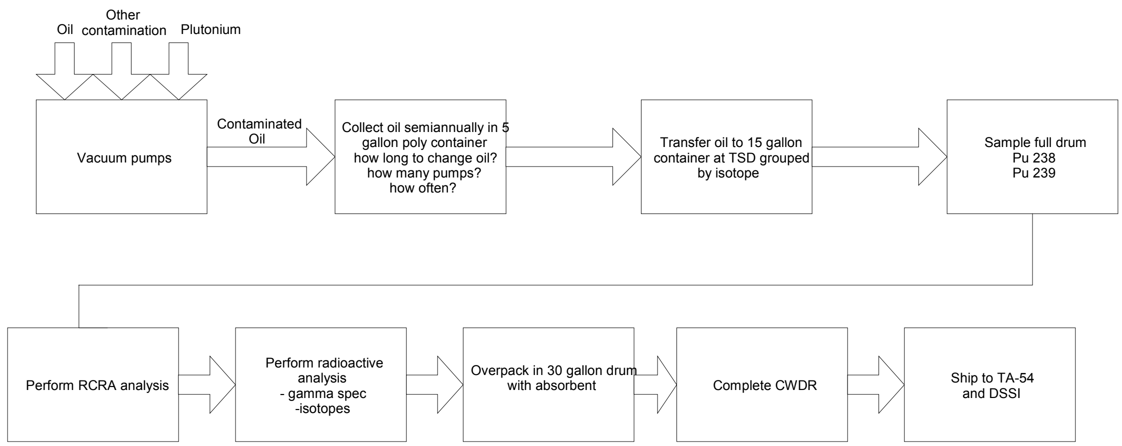
Process Mapping

The team prepared a process map for the generation and disposal of MLLW oil (see Figure 1). Oil is used in vacuum pump systems and becomes contaminated with RCRA and radioactive materials. The oil removed from these systems semiannually in 5 gallon poly containers and transferred to 15 gallon containers. The 15 gallon containers are grouped by isotope (Pu-238, Pu-239). The full containers are sampled and analyzed for RCRA and Radioactive constituents. Following sampling and characterization, the 15 gallon containers are overpacked in 30 gallon drums with absorbent. A chemical waste disposal request (CWDR) is prepared and then the waste is shipped to TA-54 for disposition to a MLLW treatment/disposal facility.

Figure 1



Activity Based Costing

Costs associated with the different process steps are difficult to determine because they are so dependent on the amount and frequency of material processing. The waste management costs are fixed at approximately $88,000 per cubic meter. Waste profile forms (WPFs) are typically prepared annually while CWDRs are prepared for each shipment to TA-54. On an average, NMT generates approximately 1 cubic meter of MLLW oil annually (8- 30 gallon drums). A WPF is prepared once a year and CWDRs are prepared twice a year. For the purposes of this analysis, it is assumed that it takes an average of 2 hours to change out and collect the oil from a vacuum pump and that an average of 5 change outs are required to fill 1-15 gallon container. Based on these values, the following table presents the costs associated with the process steps defined in the process mapping activity.

Activity	**Labor Hours, etc.**	**Cost**
Change out and collect oil in 5 gallon containers (242 pumps 2x/year 1operator, 1 supervisor, 1.5 hours per change out)	806 hrs	**$36,283**
Transfer oil into 15 gallon containers (484 transfers x 5 minutes each transfer)	40 hours	**$1,724**
Sample Drum (20 drums/year, RCRA and radioactive)	40 hrs	**$5,400**
Perform radioactive and chemical analysis ($1,025/drum)		**$29,000**
Overpack in 30 gal drum (20 drums/year, 1 hr –3 people/drum)	20 drums	**$3600**
Complete WPF (Annually)	4 hrs	**$360**
Complete CWDR (Semiannually) 2*1 hrs	2 hrs	**$180**
Transport to TA-54 – twice yearly, 2hrs each shipment	4 hrs	**$360**
Disposal Charge ($36.84/kg * 788 kg)	788 kg	**$29,390**
Total		**$105,937**

The costs presented in the table are depicted in Figure 2.

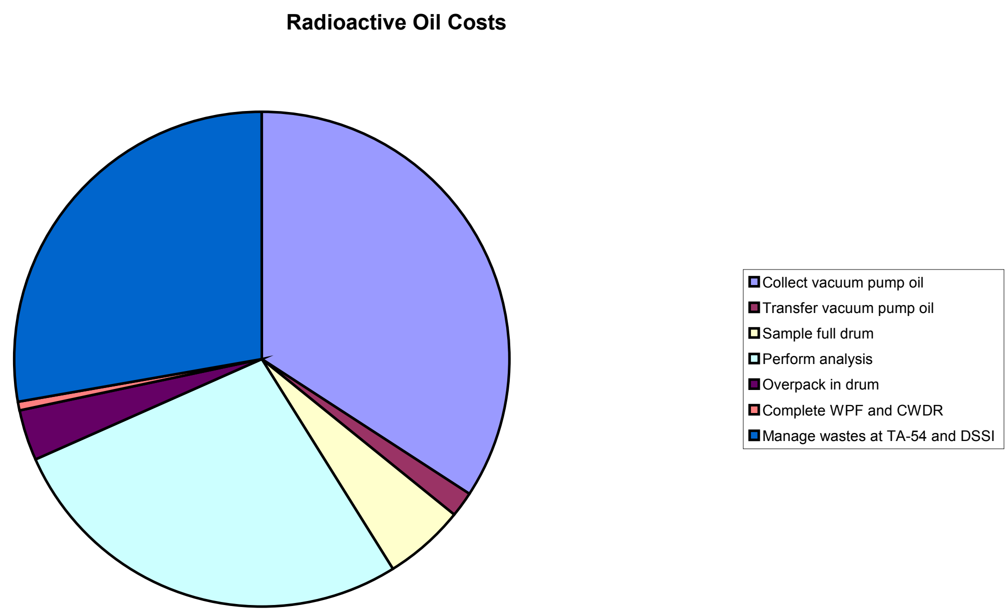


Figure 2

Figure 2 clearly illustrates, that the cost of waste disposal is similar to the collection and analytical costs.

Root Cause Analysis and Statement of Problem

The team examined the issues associated with the generation of MLLW oil with a cause and effect diagram to identify potential causes of the problem. The diagram is presented in Figure 3. The following is a detailed list and description of the items present on the cause and effect diagram.

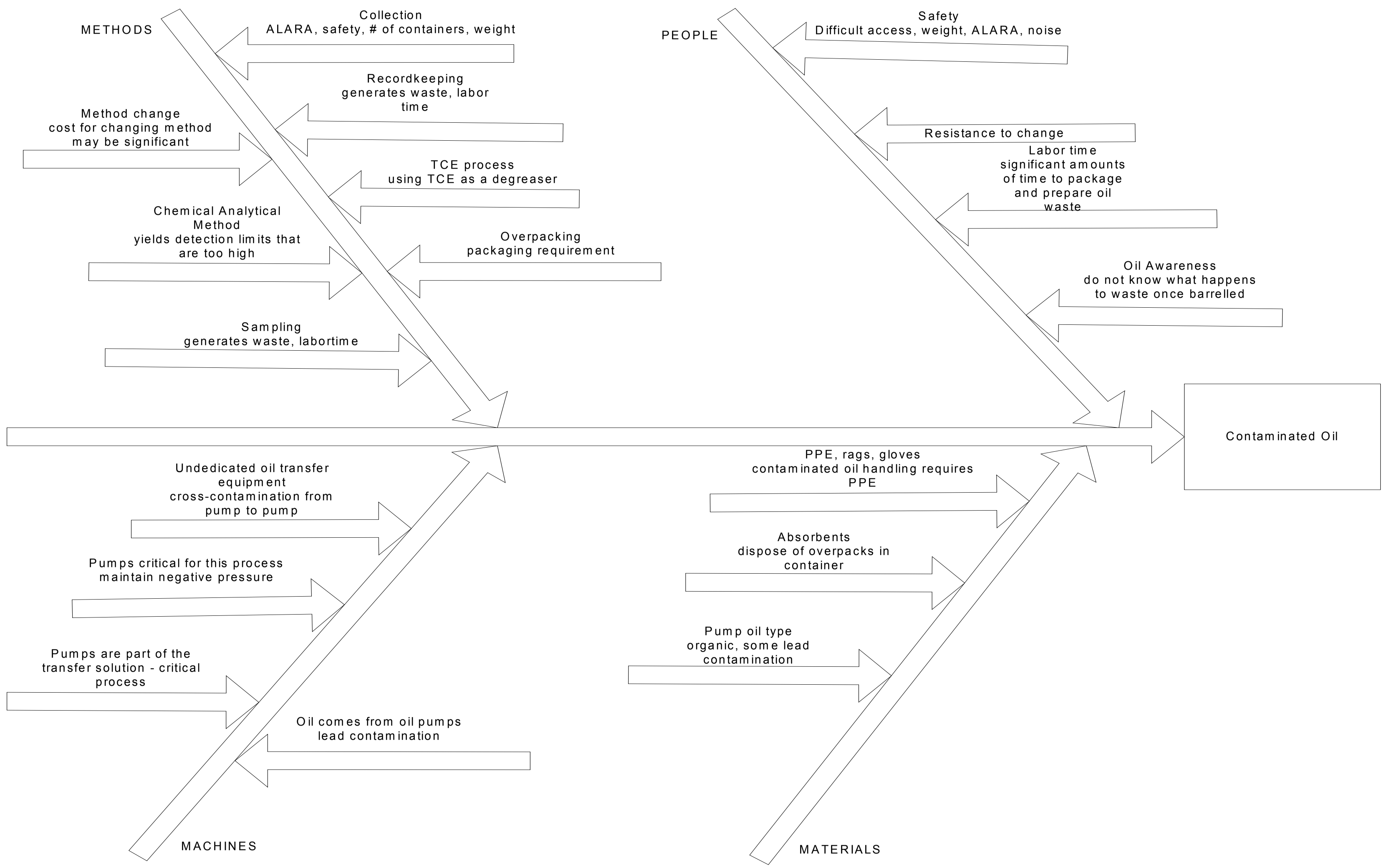

METHODS
Collection
ALARA, safety, # of containers, weight
Recordkeeping
generates waste, labor time
Method change
cost for changing method may be significant
TCE process
using TCE as a degreaser
Chemical Analytical Method
yields detection limits that are too high
Overpacking
packaging requirement
Sampling
generates waste, labortime
PEOPLE
Safety
Difficult access, weight, ALARA, noise
Resistance to change
Labor time
significant amounts of time to package and prepare oil waste
Oil Awareness
do not know what happens to waste once barrelled
Contaminated Oil
Undedicated oil transfer equipment
cross-contamination from pump to pump
Pumps critical for this process
maintain negative pressure
Pumps are part of the transfer solution - critical process
Oil comes from oil pumps
lead contamination
MACHINES
PPE, rags, gloves
contaminated oil handling requires PPE
Absorbents
dispose of overpacks in container
Pump oil type
organic, some lead contamination
MATERIALS

Figure 3

- Undedicated oil transfer equipment could cross-contaminate oil
- Pumps are a critical part of the process and substitution with other pump types may be difficult and require a change in the authorization basis
- Oil comes from oil filled vacuum pumps, substitute oil-free vacuum pumps
- Lead and cadmium primary contaminates
- Handling of oil generates PPE, rags, gloves and other solid wastes
- Volume doubled due to the need for overpacking and use of absorbents for liquid wastes
- Pump oil is petroleum based – substitution with bio-based oil may eliminate some RCRA contaminates
- Sampling generates wastes and increases labor costs
- Chemical analytical methods have detection limits that are too high. When detection limits are above the regulatory limits, it is assumed that the contaminant is present and that waste code is assigned to the oil.
- TCE is used as a degreaser and could result in the generation of TCE contaminated oil.
- The costs to change the current methods could be significant
- People are resistant to change
- ALARA, safety, and the number of containers must be considered during the collection process
- Record keeping caused by the need to manage waste and multiple containers generates wastes and labor costs
- Difficult access to oil generation areas, drum waste, ALARA, and noise are all important safety issues.
- People are not aware of the costs associated with the generation of MLLW oil.

Team members were requested to review the results of the root cause analysis and prepare a statement that captured what each person thought were the major issues involved in the generation of MLLW oil. The following consensus statement of the problem was prepared.

Oil from vacuum pumps is currently being disposed of as MLLW. This is a significant problem because of the costs associated with the management and disposal of this waste stream. There are at least three causes that contribute to this situation:

- *The use of oil-filled vacuum pumps*
- *Lead and cadmium contamination*
- *TCE contamination*

Generating Process Alternatives and Selecting Alternatives

A brainstorming tool was used by the team to generate possible alternatives to the problem. The team used a forced pair comparison to select alternatives that should be implemented in the near term. The final ordering was reviewed by the team and is presented below. The last ten alternatives were eliminated due to practical considerations that are given in brackets.

1. Solidification of the oil using an absorbent such as NoChar at the point of generation. Several other ideas may need to follow as this alternative is explored.
    a. Filter oil prior to solidification.
    b. Use synthetic oil if petroleum oil contains contaminants of concern.
    c. Use dedicated transfer equipment to avoid cross-contamination for tritium- or TCE-contaminated oil.
    d. Develop new method for analyzing oil that does not require applying waste codes for low detection limits.
2. Reuse/recycle the oil used in the large pumps.
3. Perform vacuum pump study to verify the need for each vacuum pump, determine whether it can be replaced by an oil-less pump (not roughing pumps), and determine whether the number of pumps can be can be minimized by connecting pumps through a common manifold with a pump from another glovebox.
4. Use in-line HEPA filters on small vacuum pumps [volume of oil in pump too small].
5. Bulk oil in larger quantities [equipment can only handle 12 gallon weight].
6. Use non-pump methods to generate vacuum [used to use roots blowers to generate vacuum, but the pump and oil got hot and the impellers were easily damaged].
7. Buy pumps that do not create lead and cadmium contamination [no such pump is known].
8. Increase awareness training on oil waste management [waste management coordinator also provides this training for every generator].
9. Extend pump life by having a valve position indicator on the glovebox [242 indicators cost-prohibitive].
10. Collect aliquots of oil from each into sample drum for average contamination [regulations require radioactive analysis from each drum].
11. Eliminate overpacking [Department of Transportation requirement].
12. Use Nash pumps for main vacuum [water vapor sublimates into dry system].
13. Find solvent substitution for TCE [weapons design specification require this solvent].

Action Plan

The team decided to implement alternative 1 through 3 at this time. The following action plan was prepared by the team to implement the chosen alternatives:

Action Item	**Organization**	**Due Date**	**Comments**
Develop solidification process	NMT-7/RRES-AT	9/02	
Investigate potential for superfiltration unit for house vacuum pumps	JCNNM	8/02	
Develop project to study vacuum pump use in TA-55	NMT-7/JCNNM	9/02	